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## Research article

### BIOCHEMISTRY TEACHING: IT'S TIME TO PREPARE FOR MULTIDISCIPLINARY INTEGRATION

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## ABSTRACT

**Background:** Biochemistry is taught for 1<sup>st</sup> MBBS students without much emphasis on its relevance to medicine. This makes the subject less interesting for students. Medical Council of India (MCI) in its revised regulations on graduate medical education has started the process of integration of medical teaching. **Objectives:** Study intends to identify the areas of biochemistry subject for multidisciplinary, integrated teaching that will help in framing an effective educational programme. **Methodology:** MBBS curriculum based on the Medical Council of India regulations on graduate medical education 1997 was obtained. Course content of each subject was discussed with two subject experts of concerned speciality. Subject content that overlaps with biochemistry or topics that need preliminary knowledge of biochemistry for better understanding of concerned subject were noted, as they form potential areas for integrated teaching. Information gained from all ten major subjects was compiled to arrive at results. **Results:** Nearly 75% of topics (90 classes) could be taught by integrated teaching. Topics like Chemistry of biomolecules, Bioenergetics, Quality control and few metabolic pathways (30%) were not amenable for integrated teaching. **Conclusion:** Biochemistry can be made more relevant to learner by use of integrated teaching. MCI has recommended multidisciplinary integration of subjects and our study is a humble beginning in this direction.

**Key words:** Biochemistry, Integrated teaching.

## INTRODUCTION

Biochemistry is a subject taught to MBBS students during their first year of medical education. It is taught to the students without much emphasis on its relevance to life in health and disease. It makes the subject less interesting and less relevant. Use of clinical correlations try to bridge the gap, however, students more often fail to understand them due to lack of clinical exposure. Similarly during III-MBBS, students find it difficult to comprehend the molecular basis of disease which is an essential component for understanding pathophysiology and natural course of the disease. Integrated teaching paves the way for

better understanding of the concept by learners in these scenarios. Integrated teaching offers many advantages and can be an essential factor in delivery of an effective educational programme.<sup>1</sup>

The necessity for greater integration of subjects in medical curriculum has been stressed in recommendations and reports of General Professional Education of the Physicians (GPEP) of United States of America<sup>2</sup> and General Medical Council of United Kingdom.<sup>3</sup> In its Graduate medical education Regulations 1997,<sup>4</sup> Medical Council of India (MCI) has stated the need for integrated teaching of subjects. Further, in its Graduate medical education

Regulations 2012,<sup>5</sup>MCI has initiated the process of multidisciplinary integration of subjects both horizontally and vertically. However MCI has not defined the subject wise areas for integration.

Identifying the areas of biochemistry subject for its multidisciplinary integration forms a first step in this direction and hence the study was conducted.

**Objective:** Study intends to identify the areas of biochemistry subject for multidisciplinary, integrated teaching that will help in framing an effective educational programme.

## MATERIALS AND METHODS

The study was conducted at Bidar Institute of Medical Sciences, Bidar, Karnataka, involving inputs from subject experts of different subject specialities. Some subject experts from other colleges were also consulted. This survey was a prospective observational study that spanned over a period of 3 months from June 2014 to August 2014. Ethical clearance was obtained from the Institutional Ethics Committee, Bidar Institute of Medical Sciences, Bidar. Subject experts with MBBS teaching

experience of not less than 5 years were only considered for study as subject experts.

Curriculum of MBBS based on regulations of Graduate Medical Education 1997 of MCI was obtained. Course contents of all subjects (Anatomy, Physiology, Biochemistry, Pharmacology, Pathology, Microbiology, Forensic Medicine, Community medicine, General medicine, Surgery and Obstetrics and gynaecology) were segregated.

The course content of each subject was discussed with two subject experts from the concerned speciality who have teaching experience of not less than five years in an MCI recognized medical college after post-graduation.

Subject contents that overlap with Biochemistry or topics of other specialities that need preliminary knowledge of Biochemistry for better understanding of concerned topic or subject area were noted, as these are potential areas for integrated teaching. Information obtained from all ten major subjects was compiled to segregate subject wise areas for integrated teaching and also to mark the areas of biochemistry that are not amenable for multidisciplinary integration.

## RESULTS

Topics and subject areas that need integration with Biochemistry for better understanding of subjects are shown below. (Table-1 to 10)

**Table: 1. Topics that can be integrated with Anatomy**

<ul style="list-style-type: none"> <li>• Hormones of Gametogenesis, Uterine cycle, Placenta</li> <li>• Genetics (except cytogenetics)</li> <li>• Principles of Endocrinology, Immunology</li> </ul>	<ul style="list-style-type: none"> <li>• Neurotransmitters</li> <li>• Enzymes of digestive system.</li> <li>• Proteins of connective tissues</li> <li>• Actin, myosin, Collagen, Chondroitin, Bone tissue</li> </ul>
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**Table: 2. Topics that can be integrated with Physiology**

<ul style="list-style-type: none"> <li>• Cell membranes               <ul style="list-style-type: none"> <li>– Lipids, Proteins, Transport.</li> </ul> </li> <li>• Metabolism               <ul style="list-style-type: none"> <li>– Carbohydrates, Lipids, Proteins, Haemoglobin and Haemoglobinopathies, Jaundice</li> </ul> </li> <li>• Nerve muscle physiology               <ul style="list-style-type: none"> <li>– Neurotransmitters, Muscle proteins, Creatine, ATP, Myelin, Cholinesterase</li> </ul> </li> <li>• Gastro intestinal system               <ul style="list-style-type: none"> <li>– Gastrointestinal hormones and Enzymes of gastrointestinal tract, Digestion and absorption, Bilirubin, gall stones</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Renal Physiology               <ul style="list-style-type: none"> <li>– Acid, base, Water and electrolyte balance, Renal function tests, Renal stone analysis.</li> <li>– Renin-Angiotensin system and Nitric oxide</li> </ul> </li> <li>• Endocrinology</li> <li>• Reproduction               <ul style="list-style-type: none"> <li>– Changes in pregnancy, Prenatal diagnosis, Preterm/neonatal screening</li> </ul> </li> <li>• Cardiovascular system               <ul style="list-style-type: none"> <li>– Diagnosis of myocardial infarction, Mechanism of hypertension</li> <li>– Atherosclerosis</li> </ul> </li> <li>• Central Nervous system               <ul style="list-style-type: none"> <li>– Mediators of sleep-wake;</li> <li>– Cerebrospinal fluid analysis</li> </ul> </li> </ul>
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<ul style="list-style-type: none"> <li>• Respiratory system <ul style="list-style-type: none"> <li>– Gas transport, acid base balance and regulation, Arterial blood gas analysis, Chemical regulation of respiration</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>– Synapse, Mechanism of Alzheimer's, Parkinson's disease</li> <li>– Special sense mediators</li> </ul>
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**Table: 3. Topics that can be integrated with Pharmacology**

<ul style="list-style-type: none"> <li>• Biotransformation <ul style="list-style-type: none"> <li>– Phase-1 and 2 reactions</li> </ul> </li> <li>• Drugs of Blood <ul style="list-style-type: none"> <li>– Iron, Folic acid, Vit-B12</li> <li>– Vit-K, Lipoproteins</li> <li>– Heparin, anticoagulants</li> </ul> </li> <li>• Autocoids <ul style="list-style-type: none"> <li>– Arachidonic acid, Prostaglandins, Thromboxanes</li> </ul> </li> <li>• Endocrine system <ul style="list-style-type: none"> <li>– Mechanism of action</li> <li>– Calcium, Vitamin D</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Gout <ul style="list-style-type: none"> <li>– Uric acid metabolism</li> <li>– Mechanism of action of drugs</li> </ul> </li> <li>• Isomerism</li> <li>• Hypolipidemic drugs</li> <li>• Receptors <ul style="list-style-type: none"> <li>– Insulin, Histamine, Muscarinic, cholinergic</li> <li>– 5-HT</li> </ul> </li> <li>• Mechanism of action of Non-steroidal anti-inflammatory drugs</li> <li>• Therapeutic Drug Monitoring</li> </ul>
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**Table: 4. Topics that can be integrated with Pathology**

<ul style="list-style-type: none"> <li>• Cell injury <ul style="list-style-type: none"> <li>– Accumulation; fat, protein, glycogen, pigments</li> <li>– Amyloidosis</li> </ul> </li> <li>• Inflammation <ul style="list-style-type: none"> <li>– Mediators of inflammation</li> </ul> </li> <li>• Immunoglobulins; antigenicity</li> <li>• Circulation <ul style="list-style-type: none"> <li>– Water electrolyte balance</li> <li>– Edema, albumin,</li> </ul> </li> <li>• Cardiovascular system <ul style="list-style-type: none"> <li>– Lipid profile, Hypertension</li> <li>– Cardiac enzymes</li> </ul> </li> <li>• Endocrine <ul style="list-style-type: none"> <li>– Hormone analysis</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Neoplasia <ul style="list-style-type: none"> <li>– Cell cycle</li> <li>– Oncogene, tumour markers</li> </ul> </li> <li>• Nutrition <ul style="list-style-type: none"> <li>– Protein energy malnutrition, Vitamin deficiency</li> <li>– Mineral metabolism</li> </ul> </li> <li>• Genetics <ul style="list-style-type: none"> <li>– Basics,</li> <li>– Molecular diagnostics</li> </ul> </li> <li>• Haematology <ul style="list-style-type: none"> <li>– Haemoglobinopathies, electrophoresis</li> <li>– Coagulation profile</li> </ul> </li> <li>• Hepatobiliary system <ul style="list-style-type: none"> <li>– Liver function tests, gall stone analysis</li> <li>– Jaundice, Bilirubin</li> </ul> </li> </ul>
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**Table: 5. Topics that can be integrated with Microbiology**

<ul style="list-style-type: none"> <li>• Cell and Bacterial cell</li> <li>• Bacterial metabolism</li> <li>• Bacterial genetics</li> <li>• Interferon and cytokines</li> <li>• Prion and slow virus diseases</li> <li>• Central nervous system infections, Tuberculosis, Meningitis <ul style="list-style-type: none"> <li>– CSF analysis,</li> <li>– Polymerase chain reaction</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Protein and DNA electrophoresis</li> <li>• Laboratory management and safety <ul style="list-style-type: none"> <li>– Sample collection, storage and transport</li> <li>– Disinfection</li> <li>– Lab acquired infections</li> <li>– Biosafety cabinets</li> <li>– Measuring immune functions</li> </ul> </li> </ul>
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**Table: 6. Topics that can be integrated with Forensic medicine**

<ul style="list-style-type: none"> <li>• Toxicology <ul style="list-style-type: none"> <li>– Measurement of toxin levels</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Biochemical changes after death</li> <li>• Alcohol measurement in breath and blood</li> </ul>
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**Table: 7. Topics that can be integrated with Community Medicine**

<ul style="list-style-type: none"> <li>• Mechanism, screening and diagnosis of Non-communicable diseases             <ul style="list-style-type: none"> <li>– Diabetes mellitus, Hypertension, Obesity, Cardiovascular diseases</li> </ul> </li> <li>• Nutrition and health             <ul style="list-style-type: none"> <li>– Diet planning, balanced diet,</li> <li>– Micro and macronutrients</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Genetics and health</li> <li>• Population genetics</li> <li>• Environmental health             <ul style="list-style-type: none"> <li>-Wateranalysis</li> <li>-Air analysis</li> </ul> </li> </ul>
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**Table: 8. Topics that can be integrated with General Medicine**

<ul style="list-style-type: none"> <li>• Nutrition and xenobiotics             <ul style="list-style-type: none"> <li>– Balanced diet, Protein energy malnutrition.</li> <li>– Diet planning, Obesity</li> <li>– Vitamins</li> <li>– Fluid and electrolyte balance</li> <li>– Alcohol metabolism and Blood alcohol levels</li> </ul> </li> <li>• Haematology             <ul style="list-style-type: none"> <li>– Haemoglobinopathies and Haemoglobin variants</li> <li>– Bleeding time, Clotting time</li> </ul> </li> <li>• Respiratory system             <ul style="list-style-type: none"> <li>– Mediators of allergy, asthma</li> <li>– Arterial blood gas analysis, surfactant,</li> <li>– Pleural fluid analysis</li> </ul> </li> <li>• Genetics</li> </ul>	<ul style="list-style-type: none"> <li>• Cardiovascular system             <ul style="list-style-type: none"> <li>– Cardiac enzymes,</li> <li>– C-reactive protein</li> <li>– Lipid profile, Vanillylmandelic acid assay</li> <li>– Hormone assay,</li> <li>– Arterial blood gas assay and electrolyte analysis</li> <li>– Homocysteine assay</li> </ul> </li> <li>• Gastrointestinal tract             <ul style="list-style-type: none"> <li>– Liver function tests, stool analysis</li> <li>– Gastric Juice analysis</li> <li>– Blood ammonia</li> </ul> </li> <li>• Metabolic diseases</li> <li>• Endocrine disorders             <ul style="list-style-type: none"> <li>– Hormones: structure, mechanism, assay.</li> </ul> </li> <li>• Molecular mechanism of diseases</li> <li>• Laboratory diagnosis of all diseases</li> </ul>
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**Table: 9. Topics that can be integrated with Surgery**

<ul style="list-style-type: none"> <li>• Neoplasia             <ul style="list-style-type: none"> <li>– Tumour markers, genetic basis of disease</li> </ul> </li> <li>• Hepatobiliary system:             <ul style="list-style-type: none"> <li>– Cholelithiasis, Cholecystitis, Gall stone, analysis</li> <li>– Ascites,</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Acid base homeostasis</li> <li>• Water electrolyte homeostasis</li> <li>• Diagnostic support with ABG, electrolytes, point of care testing</li> </ul>
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**Table: 10. Topics that can be integrated with Obstetrics and gynaecology**

<ul style="list-style-type: none"> <li>• Diagnosis of pregnancy:             <ul style="list-style-type: none"> <li>– Screening for genetic disorders</li> <li>– Screening for metabolic disorders.</li> </ul> </li> <li>• Neoplasia             <ul style="list-style-type: none"> <li>– Tumour markers, genetic basis of disease</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Diagnosis of pre, intra, peri, and post natal disorders.</li> <li>• Gestational diabetes</li> <li>• Iron and Folic acid</li> <li>• Hormones of menstrual cycle</li> <li>• Water electrolyte homeostasis</li> <li>• Infertility workup with hormones analysis</li> </ul>
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Topics that were not amenable for integration with other subjects are shown below. (Table 11)

**Table: 11. Topics that can't be integrated with other subjects of MBBS.**

- Hydrogen ion concentration; Acids, bases and Buffers. Henderson Hasselbalch equation
- Isotopes, radioactive isotopes and their application in medicine.
- Chemistry of carbohydrates
- Chemistry of lipids
- Chemistry of aminoacids and proteins
- Chemistry of nucleic acids
- Enzymes: Chemistry, classification, specificity, cofactors, activators, Km value, Mechanism of action of enzymes.
- Intermediary metabolism
- Biological oxidation and electron transport chain.
- Quality control and standardisation in laboratory
- Calorific value, Respiratory quotient, Specific dynamic action
- Metabolic changes in starvation.

For teaching of biochemistry syllabus, MCI has stipulated 120 lecture classes. Nearly 30 classes (25%) are not amenable for integrated teaching and are to be taught in isolation; while rest of the topics (75%) can be integrated with other subjects.

## DISCUSSION

Biochemistry is taught to I-MBBS students with little emphasis on its correlations to diseases. It makes the subject less relevant and less interesting to students. To overcome this deficit, impetus has been given to integrated teaching.

Graduate medical education regulations -2012 framed by MCI outline the plan for integration without defining the subject areas or topics for integration. Our study has identified the areas of Biochemistry subject that can be integrated with all major subjects of MBBS. Our study is the first of its kind and is a small beginning in this direction.

Many studies have shown the usefulness of multidisciplinary, integrated teaching by case based learning and problem based learning in Indian medical schools.

Problem based learning, a type of integrated teaching was found to be effective in analysing and understanding clinical problems and also was found to arouse interest and enthusiasm in teaching learning activity.<sup>6</sup> Integrated teaching splits the complicated areas into easy small blocks that can be understood by learner easily.<sup>7</sup> Students' preferred integrated teaching over conventional methods as they found it to be useful and interesting.<sup>8, 9, 10,11,12.</sup> System-based learning modules for integrated teaching were developed by some researchers and found to be useful than conventional teaching methods.<sup>13</sup> Problem based learning in biochemistry was found to be

associated with learning gains and development of skills, values and attitudes.<sup>14</sup>

Hurdles are many for implementation of integrated teaching in medicine, but its benefits outweigh the difficulties of implementation in Indian scene.<sup>15</sup>

**Limitations of the study:** Study considered opinions of only two subject experts per each speciality. Study did not take into account of learners' opinion regarding choosing topics for integration. Temporal integration and assessment that pose major challenge for integrated teaching were not considered for study.

## CONCLUSION

Majority of Biochemistry subject (75%) can be integrated with other subjects for multidisciplinary integrated teaching to make it more interesting and relevant for the learners. This study provides the outline of Biochemistry topics amenable for integration to curriculum developers and subject experts of MCI for integrating Biochemistry with other subjects.

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**Conflict of Interest:** Nil

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